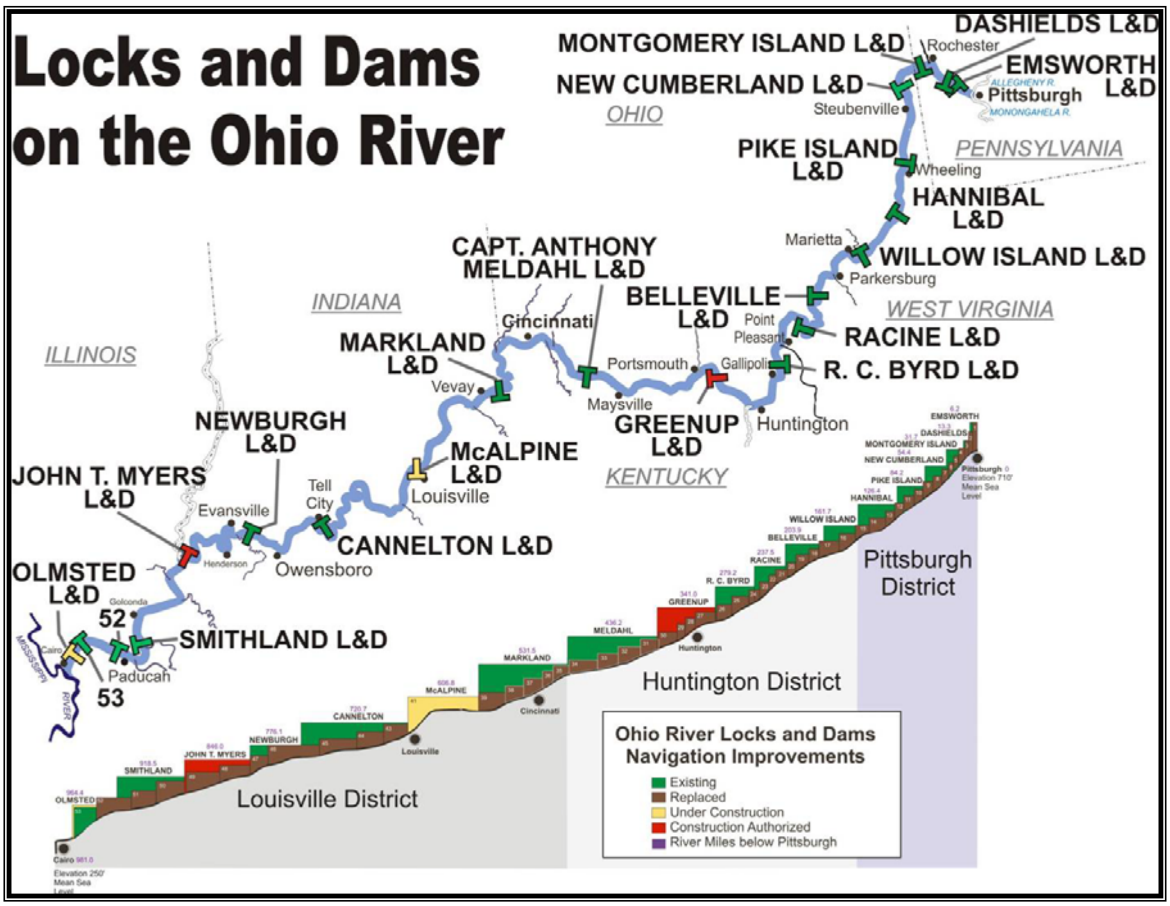
EXECUTIVE SUMMARY

1. Valuing Navigation on the Ohio River System.

The Ohio River Mainstem is the principal artery of the Ohio River System (ORS), which also includes the navigable tributaries Allegheny, Monongahela, Kanawha, Big Sandy, Kentucky, Green, Tennessee and Cumberland rivers. Users of the Ohio River System ship by barge 270 million tons of commodities worth over $30 billion, saving over $2 billion in transportation costs annually. These savings result in additional national output estimated at over $11 billion, which makes possible approximately 100,000 jobs and $3 billion in income.[1]

Figure 1
Ohio River Mainstem Plan and Profile

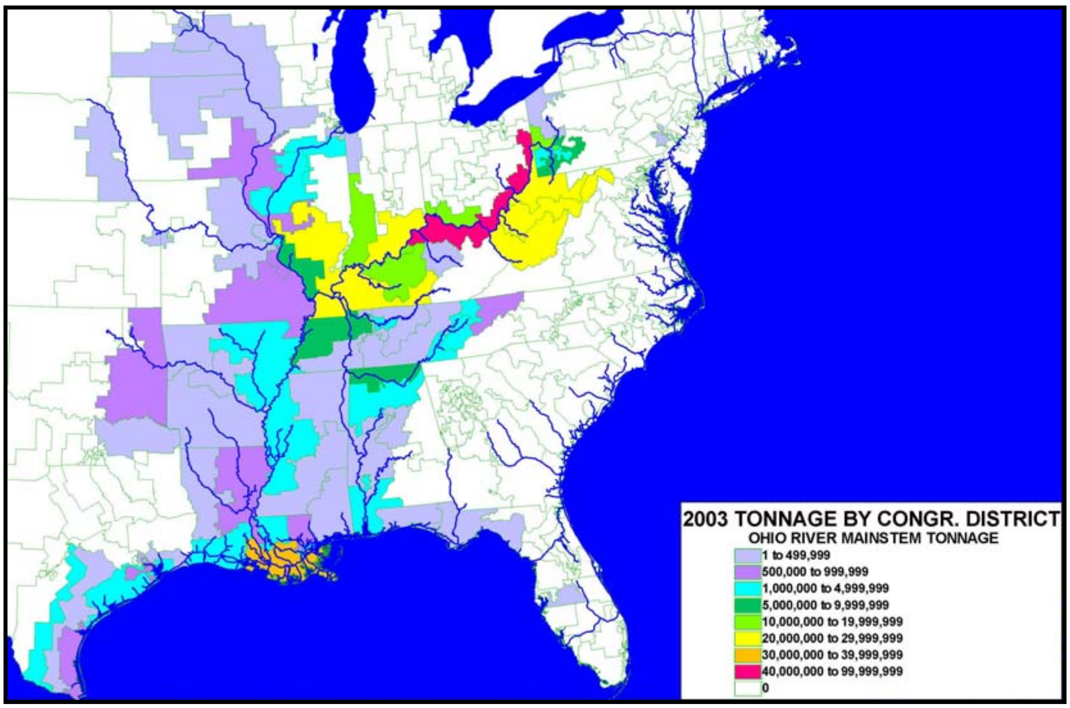


[1] *Regional Economic Development Impacts on the Ohio River Basin due to Commodity Savings Along the Ohio River System*, September 1999, Marianne Matheny, USACE-NAB and Dennis Robinson, USACE-IWR

The Ohio River Basin (ORB) is rich in natural resources and is home to over 31.5 million people. There are 57 coal-fired power plants in the ORS that provide 20 percent of the nation's coal-fired electric generation capacity. One of the primary reasons the electricity rates in the region are among the lowest in the nation is the relatively inexpensive transportation costs to deliver coal to the power plants via the waterway. Per weight of commodity, coal accounts for 50-60% of the ORS waterway shipments.

The Ohio River is a major transportation artery that serves as an alternative to increasingly congested highways and rail lines for the movement of domestic cargo. Figure 2 shows the extent to which Ohio River mainstem traffic is distributed throughout the eastern United States.

Figure 2
Distribution of Ohio River Traffic*



* Any tonnage that travels at least a portion of the Ohio River.

A significant portion of Ohio River mainstem tonnage passes through Gulf ports in route to/from foreign markets. The value of the Ohio River to communities and industry is transparent during normal operation. However, when lock closures occur, traffic can be slowed or even stopped, affecting the delivery of goods and ultimately increasing costs to consumers. Recent unscheduled closures at Greenup, McAlpine, Hannibal and Montgomery locks have cost millions of dollars in additional transportation costs alone. Table 1 shows data related to these closures. The economic impacts reported in this table reflect only the delay costs imposed on tows waiting to use the lock. Several investigations following these main chamber lock closures found there are other logistical costs associated with closures that can be quite high. For example, a survey of Greenup Lock users uncovered $29 million in costs above and beyond the $13.2 million in delay costs shown in Table 1. In the present business environment of just-in-time delivery of goods and commodities, any closure interrupts production, forces movements onto other transportation modes, and increases costs which are then passed along to the consumer.

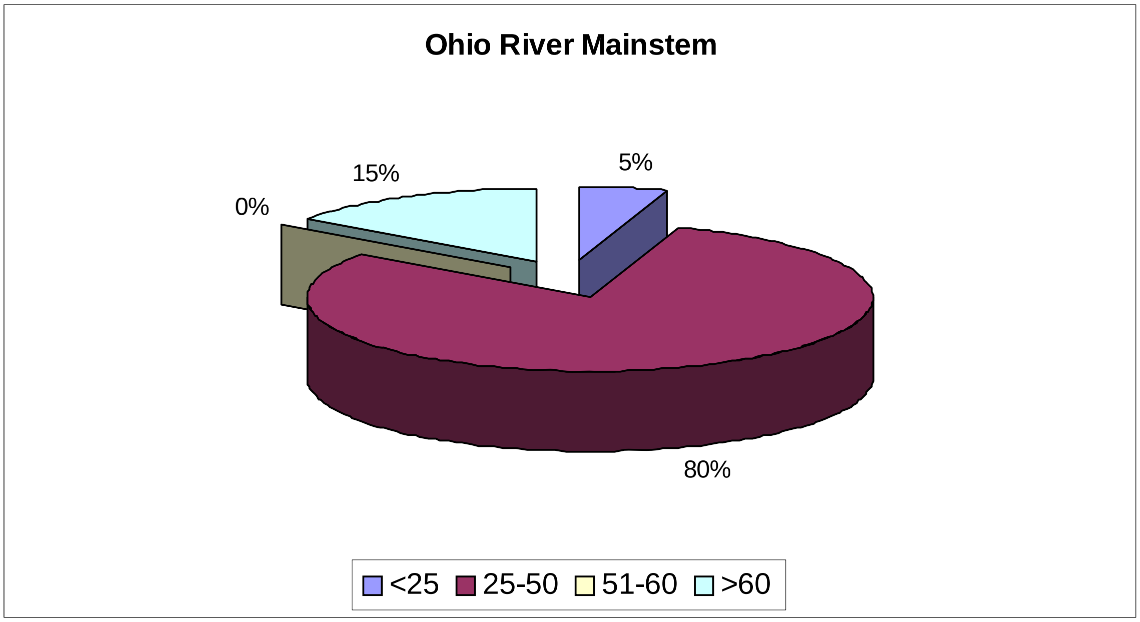
Table 1
Recent Ohio River Mainstem Lock Closures

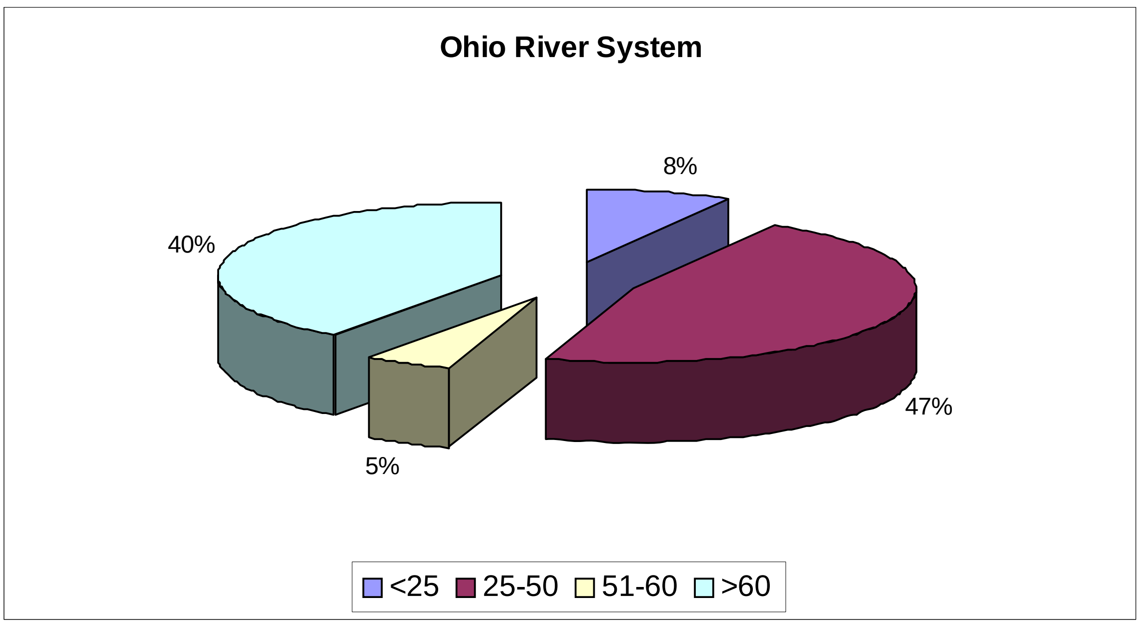
Lock	Closure Dates	Closure Duration	Delay (hrs) Max	Delay (hrs) Avg	Number of Tows Delayed	Delay Costs $
Hannibal	Nov 1 - 15, 2005	15 days	140	58	125	$ 3,000,000
McAlpine	Aug 8 - 19, 2004	10 days 23.4 hrs	257	77	19	$ 695,000
Greenup	Sep 8 - Oct 31, 2003	52 days, 8 hrs	93	38	718	$ 13,200,000
Montgomery	Jun 18 - 28, 2002	10 days, 17 hrs	110	34	130	$ 1,200,000
Montgomery	Jul 15 - 31, 2002	16 days, 16 hrs	132	33	179	$ 1,700,000

Source: Lock Performance Monitoring System (LPMS) and Institute for Water Resources (IWR) cost data.

The lock closures cited above are symptomatic of an aging infrastructure and projects with small auxiliary lock chambers. As locks reach the limits of their design life, closures of main chambers for repair become more likely. When these closures occur, smaller auxiliary lock chambers must carry the entire traffic burden. Because these chambers are smaller, tows must be uncoupled and moved through in multiple lockage operations (usually two lockage cuts) rather than a typical single cut lockage operation used at a main chamber. The multiple cut lockages take nearly three times as long, and at many lock projects this additional time leads to the lengthy delays shown in Table 1. The age distribution of the mainstem locks is shown in Figure 3. Figure 3 also shows that the vast majority of Ohio River locks are between 25 and 50 years of age, with 15% of locks being greater than 50 years of age. For the system as a whole, nearly half of the locks are between 25 and 50 years of age, and another 45% are over 50 years old, indicating that the problem of aging infrastructure is even more acute on the Ohio River's navigable tributaries. By 2015 locks over 50 years of age represent 40% of Ohio River locks and 68% of Ohio River System locks.

Figure 3
Age Distribution
Ohio River Mainstem and Ohio River System Main Lock Chambers





2. Study Purpose.

The primary purpose of the Ohio River Mainstem Systems Study (ORMSS) is to develop the best System Investment Plan (SIP) for maintaining safe, environmentally sustainable, and reliable navigation on the Ohio River over a 60-year period from 2010 to 2070. The study evaluated the operation and maintenance, rehabilitation, and construction reinvestment needs at the 19 navigation lock and dam sites on the Ohio River Mainstem as shown in Figure 1.[2] The study reports on five plans for meeting these needs based on five different traffic forecast scenarios. The future reliable operation of these structures is critical to the continued growth in commercial navigation throughout the Ohio River basin. In response to stakeholder input, the study purpose was modified to include the identification of measures to improve ecological sustainability to provide a balance between economic and environmental improvements.

3. Study Processes.

The ORMSS draft report is an integrated System Investment Plan (SIP) and Programmatic Environmental Impact Statement (PEIS). The PEIS is centered on a system-wide Cumulative Effects Assessment (CEA) and other studies that focused on specific issues identified through the study scoping process. The study team sought to determine effects on the sustainability of Ohio River resources from all past, present and foreseeable future activities on the river, not just those associated with navigation improvements. An Interagency Working Group (IWG) consisting of federal and state natural resource agencies and non-governmental environmental interests was involved in the development of the CEA and the PEIS.

Early in the Ohio River Mainstem Systems Study two site specific lock facilities were identified where initiation of construction was warranted prior to the completion of the System Investment Plan (SIP). These two high traffic projects, J.T. Myers and Greenup Locks and Dams, demonstrated immediate, economically justified investment opportunities during early prioritization work. Utilizing the same rigorous engineering risk and reliability-based approach used in this study, feasibility-level documentation and full NEPA analysis were produced for these 'near-term' sites: J.T. Myers and Greenup Locks and Dam. These projects were authorized by the Water Resource Development Act (WRDA) 2000. In addition, the IWG worked together to develop the Ohio River Ecosystem Restoration Program which was also authorized in WRDA 2000. Continuing along this line, an assessment of high priority needs to enhance ecological sustainability is included in the current report.

The study has benefited by the lessons learned in the Upper Mississippi River-Illinois Waterway Navigation Feasibility Study. A number of issues identified by the National Academy of Science review of that study influenced the direction of ORMSS:

- Benefits were estimated on a system basis, rather than one lock at a time.
- Nonstructural alternatives, like traffic scheduling, were evaluated.

[2] Olmsted L/D will replace L/Ds 52 and 53 when completed.

- The Ohio River Navigation Investment Model (ORNIM) was developed to fully integrate economic and engineering data.
- Modifications were made to the ORNIM model to produce input data for the Navigation Predictive Analysis Technique (NAVPAT) model, thus integrating environmental and other analyses.
- The cumulative effects analysis incorporated all actions producing impacts to Ohio River resources.
- A range of scenarios based on plausible futures was developed to account for the uncertainty inherent in forecasting.
- The Waterway Analysis Model (WAM), a component of ORNIM, used simulation modeling techniques to estimate throughput capacity.
- A risk and reliability assessment model was developed for analyzing lock structures.

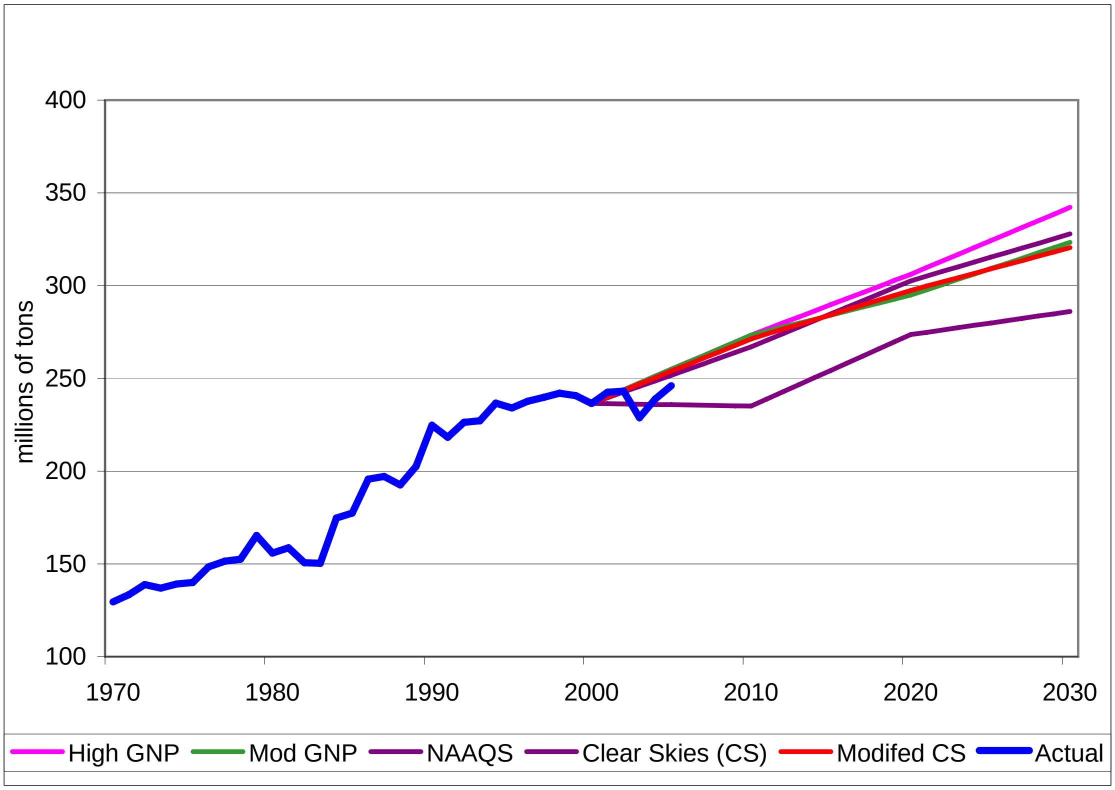
A variety of stakeholders participated in the development of the study through forums as varied as public meetings and workshops with industry groups, environmental groups, and academia. The ORMSS study team has solicited input and shared work with all interested stakeholders through various communication channels.

Independent technical review of all of the analyses has been conducted by subject matter experts. The independent technical review of the economics was completed entirely by experts external to the Corps and included two members of the National Academies of Science. Whether these experts were from academia, other agencies, or within the Corps, their reviews have provided authenticity and veracity to the conclusions and recommendations contained herein. An In-Progress Review was also conducted in February 2004 with Corps Headquarters, providing an opportunity to make mid-course adjustments of the study.

4. Risk and Reliability.

The major variables in developing a system investment plan for the mainstem locks are lock condition and traffic demand. Forecasts of both variables are uncertain giving rise to the need for a risk based analysis to insure that the study conclusions and recommendations cover the plausible range of future scenarios. Engineering reliability models were used to analyze lock component reliability and capture the uncertainty of lock performance while accommodating forecasted traffic demand. Multiple traffic forecasts were used to model river traffic. Five forecasts were developed for the study, each recognizing that the primary driver of river traffic is utility coal at 50-60% of system tonnage transported (see Figure 4). Traffic forecasts used in this study indicate that demand for Ohio River navigation is projected to grow between 0.51-1.06 percent annually, depending on the forecast scenario. Forecasted growth is confirmed by recent announcements made regarding clean-coal technology plants, expansions to coal-fired power plants, and coal gasification plants in the basin.

Figure 4
Ohio River Historic and Forecast Traffic, 1970 - 2030



High GNP -- traffic scenario incorporates high GNP growth forecasts .
Mod GNP -- traffic scenario incorporates moderate GNP growth forecasts.
NAAQS -- traffic scenario incorporates US EPA National Ambient Air Quality Standards.
Clear Skies -- traffic scenario incorporates Bush Administration proposals for emission reductions from electric power plants.
Mod CS -- traffic scenario incorporates all aspects of Bush Administration proposals for emission reductions, excepting proposals regarding Mercury.

The ORMSS process included development of a state-of-the-art analytical model that incorporated the uncertainty of traffic forecasts and the reliability of lock components into a procedure to optimize reinvestment strategies. The Ohio River Navigation Investment Model (ORNIM) used in this analysis determined system-wide benefits and costs of different reinvestment alternatives through the integration of engineering, economic and environmental inputs. ORNIM is able to evaluate tradeoffs among alternatives over time to optimize maintenance, rehabilitation and construction needs.

5. Formulation and Evaluation.

a. <u>Without Project Condition (WOPC)</u>. The without-project condition is the most likely condition expected to exist in the future in the absence of implementation of water resource project investment alternative(s). The future without-project condition constitutes the benchmark against which alternative plans are evaluated. For this study, the WOPC was formulated as the least Federal cost plan providing viable navigation on the Ohio River Mainstem. The WOPC as developed is a reactive maintenance strategy for major lock components. This assumes that as a component fails, it is repaired in a timely fashion; however, no proactive maintenance is performed, i.e., components are not repaired or replaced in anticipation of failure.

Performance of the system's aging infrastructure will continue to deteriorate in the future without aggressive maintenance or lock modernization. The three upper-most projects on the Ohio River (Emsworth, Dashields, and Montgomery (EDM)) range in age from 70 to 85 years, well beyond original design life. There are two major concerns with the physical condition of the lock walls at EDM: 1) concrete deterioration below concrete overlays placed during rehabilitations in the 1980s, and 2) questionable remaining effectiveness of metal anchors installed during those rehabilitations to make these walls stable. These problems contributed to predictions of very high future maintenance costs at EDM in the WOPC. Lock performance is also affected by the various traffic scenarios developed in this study. Consistent with Corps guidance, the WOPC also includes the timely completion of authorized improvement projects (Olmsted, McAlpine, Greenup, Myers, Marmet, Kentucky, Lower Monongahela, and Chickamauga Locks).

These physical conditions lead to lock closures. When these closures affect the main lock chamber, traffic through the project must use the smaller auxiliary lock chamber. In the case of projects with 1200' main chambers and 600' auxiliary chambers this means it will take tows two lockage operations to transit the project, and in the case of EDM with their 600' main chamber and 360' auxiliary chambers it will take tows five cuts with tow sizes limited to five rather than the typical 15 barges. All of this means additional time and operating costs to process through the lock. Where traffic exceeds the ability of the auxiliary to process traffic, tows will experience significant delays and incur additional operating costs above and beyond the additional time it takes to process a tow through the auxiliary. So both projections of the future physical reliability of the project and projections of future traffic demands will affect future lock performance.

Consistent with Corps guidance, the WOPC also includes the timely completion of authorized improvement projects (Olmsted, McAlpine, Greenup, Myers, Marmet, Kentucky, Lower Monongahela, and Chickamauga Locks).

1). <u>Economic Analysis of the WOPC</u>. The benefits of the waterway system are determined by the transportation rate savings the system affords. The WOPC benefits are estimated as the difference in total transportation costs necessary to move the system tonnage by the existing water routes versus what it would cost to move the same tonnage by the lowest cost alternative all overland routings. Garnering these benefits comes at a cost, primarily in terms of operations and maintenance costs in the WOPC. Table 2 summarizes average annual benefits and costs for the WOPC. Net benefits range from $2.15 to $2.36 billion.

2). Environmental Sustainability in the WOPC. The WOPC is also the No-Action alternative under NEPA. Looking into the future, levels of sustainability are expected to maintain or improve for all Valued Environmental Components (VECs) except for mussels and riparian/floodplain resources. Significant effects to these two categories have occurred from a number of activities which occur not only along the river but also along the basin's tributaries. These activities include, but are not limited to, water pollution from municipalities and industries; acid mine drainage; instream extraction of sand and gravel; construction and operation of high-lift locks and dams; disruptions to mussel beds due to barge fleeting areas, queuing, disposal of dredged materials, and conversion of habitat for agriculture, residential, commercial, and industrial uses. Habitat conversions are expected to continue in the future as development in or adjacent to the river continues to occur.

Table 2
WOPC Average Annual System Benefits and Costs
(2010-2070, 5 1/8%, Million FY03 $)

Ohio Mainstem System	Forecast Scenario				
	Clear Skies	Modified Clear Skies	NAAQS Growth	Utility Based	Utility Based High
Total System Benefits	$2,252.8	$2,373.7	$2,351.8	$2,428.7	$2,460.1
Total System Costs	$99.0	$100.1	$100.0	$99.8	$100.1
Net System Benefit	$2,153.8	$2,273.6	$2,251.8	$2,328.9	$2,360.1

The WOPC for ecosystem sustainability assumes full implementation of the as yet unfunded Ohio River Ecosystem Restoration Program and 14 specific types of measures[6] that were determined to contribute to long-term sustainability of aquatic and riparian ecological resources. Several of these 14 measures deal with specific types of habitat (e.g., islands, mussel habitat, etc.) and can be described as protecting and improving habitats, increasing diversity and connectivity of habitats, restoring populations of native species, and reducing invasive exotic species. These measures could be implemented through a variety of existing Corps authorities, such as the Ohio River Ecosystem Restoration Program, the Ohio River Basin Comprehensive Study , and Sections 206 and 1135, especially in collaboration with other agencies and interests. While some opportunities among the 14 are relatively low-cost and straightforward, others would require additional planning and/or construction.

The Corps operation and maintenance of the navigation system are currently being examined under Section 7 of the Endangered Species Act. In consultation with the US Fish and Wildlife Service, the Corps will develop and implement Reasonable and Prudent

[6] See Table 8-10 for a list of environmental sustainability measures in the WOPC ES Plan.

Measures being identified through this consultation. These operational measures along with restoration authorities will help to improve sustainability.

b. With-Project Condition (WPC). The with-project condition is the plan that best addresses the stated planning objectives and addresses the problems and opportunities. The planning objectives were: Ensuring Future Navigability, Improving Navigation Efficiency, and Enhancing Environmental Sustainability. To achieve these objectives, the study team developed and evaluated alternative actions ranging from proactive maintenance and small scale improvements to large-scale construction reinvestments. Proactive maintenance occurs when lock components are replaced or a lock is rehabilitated in advance of component(s) failure. Small-scale improvements considered include floating buoys, permanent mooring cells near lock approach points, and other infrastructure or procedural opportunities.[7] Large-scale reinvestments evaluated include chamber rehabilitations, construction of new larger lock chambers, and 600' extensions of some auxiliary lock chambers.

Three alternatives involving proactive maintenance and new lock construction were formulated for the WPC analysis and evaluated relative to the reactive maintenance, WOPC (see Figure 5). Two involved adding more proactive maintenance options. The first, called the Advanced Maintenance Alternative (AMA), allows for scheduled replacement of any critical lock component when economically justified. The second, termed the Major Rehabilitation Alternative (MRA), allows both component replacement and the bundling of component replacements into major rehabilitation packages that meet Corps criteria for that program, again when economically justified. A third alternative, termed the Lock Modernization Alternative (LMA), allows proactive maintenance as well as lock modernization options. Specific lock modernization options considered included 600' extensions of 600'x110' auxiliary chambers and new 600'x110' or 1200'x110' chambers to replace any of the 360'x56' auxiliaries at Emsworth, Dashields, and Montgomery (EDM).

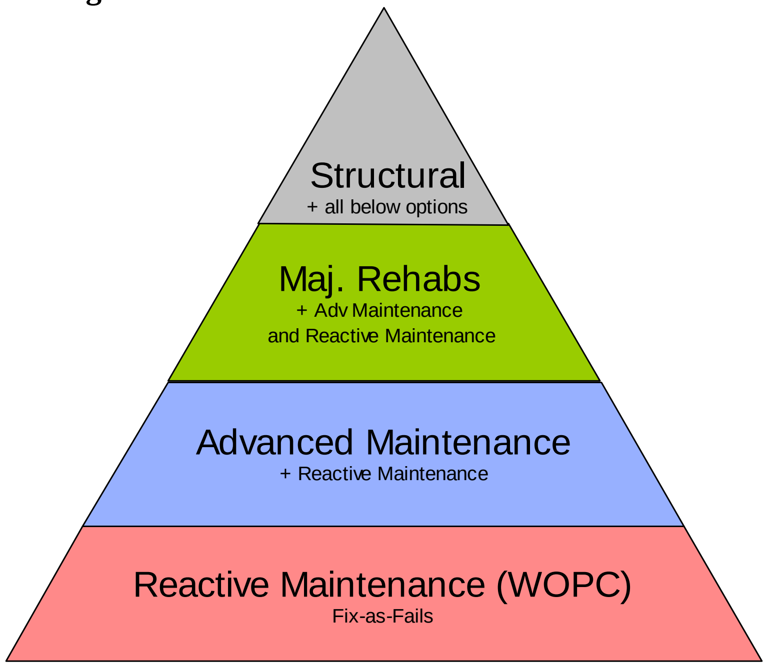
Two ecosystem sustainability alternatives were formulated for the WPC analysis to address long-term sustainability of aquatic and riparian ecological resources. The Moderate and Maximum Ecosystem Sustainability Related plans were developed based on approximate costs, need for modified or additional authority, complexity, and several scientific, policy, funding and timing uncertainties of various measures. A total of 26 ecosystem sustainability measures were evaluated; 12 specific types of measures in addition to the 14 from the WOPC. The Moderate plan included 19 of the measures and the Maximum Plan consists of all 26 measures[8]. Existing restoration authorities and operational measures such as the Reasonable and Prudent Measures are also carried through into the WPC.

---

[7] *Small Capital Improvements Study Mooring Facilities*, May 1998, USACE.

[8] The Moderate and Maximum Ecosystem Sustainability Related Plans are described in Table 8-10 of this report.

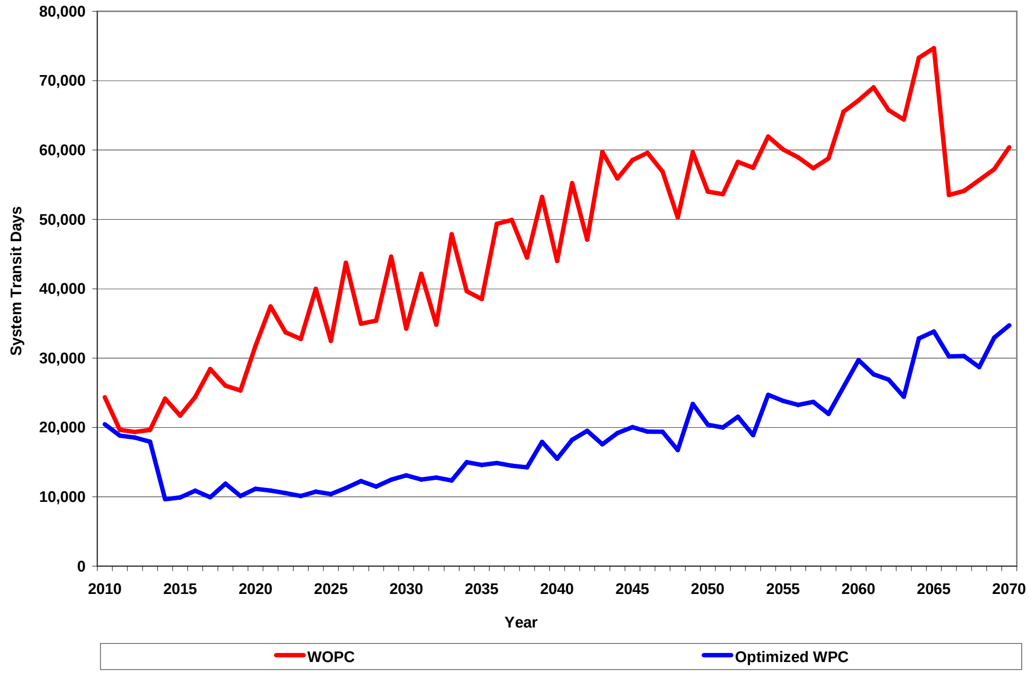
Figure 5
Progression of Alternatives in Formulation Process



1). Economic Analysis of the WPC. The operational effect of the reactive maintenance protocol of the WOPC is illustrated (by the upper red line) in Figure 3. As the system ages, component reliability degrades and in the WOPC, components are not repaired or replaced in advance of failure. The jagged nature of the graphic reflects the interruptions due to ever increasing scheduled maintenance and the greater likelihood of unscheduled reliability lock closures. More frequent closures result in increased total transit days necessary to move projected tonnage in the ORS. In the WPC, components are repaired or replaced in advance of expected failure. The actual protocol is to estimate the expected costs of component failure through the planning period and contrast those with the expected benefits of component replacement. The decision to schedule a component replacement is based on economic efficiency, i.e., when expected benefits exceed expected costs, the component is scheduled for repair or replacement. When it is more efficient to bundle the replacement of several components, a major rehabilitation is scheduled. In every instance of proactive maintenance, expected economic benefits exceed expected economic costs. As a consequence of proactive maintenance, the number of scheduled and unscheduled closure events in the WPC is less than in the WOPC. This results in a reduced number of total transit days as illustrated (by the lower blue line) in Figure 4.

Economic analyses clearly demonstrate the value to the nation of more proactive maintenance. Relative to reactive maintenance, proactive maintenance reduces future maintenance needs and unscheduled emergency repairs, while saving hundreds of

Figure 4
Transit Days to Accommodate Equilibrium Traffic
(WOPC vs. WPC)



millions of dollars annually due in transportation costs. In addition, replacing the small auxiliary locks at EDM with larger locks reduces future maintenance repair costs of the 1930s vintage main chambers, avoids costly interruptions of traffic and results in transportation savings in the tens of millions annually over and above proactive maintenance alone.

Table 3 displays the incremental benefits and costs of the WPC relative to the WOPC. The ORMSS draft SIP estimates average annual incremental net benefits for meeting mainstem long term reinvestment needs range from $128 to $238 million.

Table 3
WPC Average Annual Incremental Benefits and Costs
(2010-2070, 5 1/8%, Million FY03 $)

	Forecast Scenario				
Ohio Mainstem System	Clear Skies	Modified Clear Skies	NAAQS Growth	Utility Based	Utility Based High
Incremental Benefits over WOPC	$147.8	$237.0	$259.9	$207.0	$233.3
Incremental Costs over WOPC	$19.0	$18.6	$21.5	$18.9	$18.4
Incremental Net Benefit	$128.8	$218.4	$238.4	$188.1	$214.9
Benefit / Cost Ratio	7.8	12.7	12.1	11.0	12.7
Total Costs for Optimized WPC	118.0	118.7	121.5	118.7	118.5

The major elements of the plan that maximizes system net incremental benefits for each traffic scenario is shown in Table 4. Results are quite robust with regard to traffic scenarios; for the most part, the type of investment, whether replacement of a major component of the lock (component replacement - CR), major rehabilitation (MR), or new construction, is unchanged across scenarios and the timing of the investment shows only modest adjustment.

Table 4.
Elements of the Draft System Investment Plans

Project	Clear Skies	Modified Clear Skies	NAAQS	Utility Based	Utility Based High
Belleville	CR	MR - 2017	MR - 2017	MR - 2017	MR - 2028
Cannelton	MR - 2017	MR - 2017	MR - 2016	MR - 2017	MR - 2017
Dashields	New 600' - 2011	New 600' - 2010	New 600' - 2010	New 600' - 2010	New 600' - 2010
Emsworth	New 600' - 2010	New 600' - 2010	New 600' - 2010	New 600' - 2010	New 600' - 2010
Hannibal	MR - 2012	MR - 2011	MR - 2011	MR - 2012	MR - 2011
Markland	CR	MR - 2010	MR - 2010	MR - 2010	MR - 2010
Meldahl	MR - 2013	MR - 2010	MR - 2010	MR - 2010	MR - 2010
Montgomery	New 600' - 2010	New 600' - 2010	New 1200' - 2010	New 600' - 2010	New 600' - 2010
Newburgh	MR - 2025	MR - 2016	MR - 2016	MR - 2016	MR - 2016
Pike Island	MR - 2016	MR - 2015	MR - 2015	MR - 2016	MR - 2015
Racine	MR - 2020	MR - 2019	MR - 2020	MR - 2019	MR - 2019
RC Byrd	CR	MR - 2044	MR - 2020	MR - 2030	MR - 2033
Willow Island	MR - 2027	MR - 2027	MR - 2027	MR - 2027	MR - 2028

All lock projects at a minimum have component replacements, some have rehabs and others have new chambers added.

CR = Component Replacements
MR = Main Chamber Rehabilitation
New 600' or 1200' = New Single chamber built in place of the existing auxiliary. The old main is only used when the new chamber is down for maintenance.

2). <u>Environmental Sustainability in the WPC</u>. The best WPC plan for ecosystem sustainability was the Moderate Plan, which added five specific types of measures to the WOPC; 1) increase seasonal flooding in specific habitats, 2) protect and restore habitats and diminished resources, 3) reintroduce and expand native fauna in historic ranges, 4) re-connect tributary streams and floodplains with the Mainstem Ohio River, and 5) restore wetlands in embayments. The Moderate Plan has less scientific, policy, funding, and timing uncertainties associated with it, which makes it preferable over the Maximum Plan. The added components of the Moderate Plan would require funding in addition to that provided (in the WOPC) for the Ohio River Ecosystem Restoration Program, Ohio River Basin Comprehensive Study and existing authorities such as Sections 206 and 1135. As measures are evaluated during development of the Program Implementation Plan for the Ohio River Ecosystem Restoration Program, the need for new or modified authorities would be identified. In those cases where new or modified authority is determined to be necessary, efforts should be directed towards obtaining such authority through a basin wide study. Implementation of the Moderate WPC plan would improve the long-term sustainability of freshwater mussels and riparian/floodplain resources over that of the WOPC. However, it is not expected that this plan would provide sufficient benefits to bring these resources to a state of full sustainability.

The Lock Modernization Alternative is the best plan for long term cumulative impacts by providing a positive contribution to the environmental sustainability of water quality, fish, mussels, riparian resources, recreation, and health and safety. For example, reduction of the queuing near lock and dam projects reduces re-suspension of sediments and substrate scouring in tailwater areas which are sensitive areas for many of the remaining freshwater mussel species (some of which are federally listed) and provide important spawning habitats for several species of fish. By not diverting waterway traffic to highway and rail corridors and associated facilities, impacts of increased fuel consumption, traffic delays, air emissions, accelerated deterioration of roads, traffic-related injury, and delivery prices of diverted materials are also lessened. Implementing the projects in the Lock Modernization Alternative would result in direct and indirect impacts in the form of construction impacts and construction induced queuing. Mitigation for site-specific impacts would be incorporated into project plans developed during feasibility studies, major rehabilitation studies, or other approval processes.

It is important to note that this SIP/PEIS is a programmatic EIS under National Environmental Policy Act (NEPA). Follow-on study reports for specific projects identified within the study planning horizon will require that site-specific impacts be evaluated during preparation of project EIS(s) or Environmental Assessment(s). Following the Council on Environmental Quality regulations, these site-specific NEPA documents will be tiered from the programmatic assessment provided through this SIP/PEIS. CEQ regulations require certain topics to be considered in any EIS. These topics are addressed as follows:

- Adverse effects that cannot be avoided should the ORMSS recommendations be implemented are associated with site-specific improvements (e.g., major rehabilitations and lock modernizations).

- Implementation of the ORMSS would not result in irreversible or irretrievable commitment of resources without further evaluations necessary prior to approval or authorization of specific measures.

- Consideration of the relationship between short-term use of the environment and long-term productivity (or sustainability) was essential throughout the conduct of the study, and emphasis was placed on both preventing degradation of and enhancing long-term sustainability. This study provides the plans for and the means to optimize returns on investments in the navigation system in combination with identification of high priority ecosystem sustainability improvements.

- All alternatives contribute to energy conservation by providing lower cost delivery of coal to utilities as compared to other delivery modes. Each successive level of navigation investment reduces tow operations fuel consumption through reduction of transit times for commodity movements.

- Coal used in power plants is a depletable natural resource and is a primary commodity transported on the Ohio River mainstem. Investment in the navigation system maintains expected levels of efficiency and service and does not alter the cost competitiveness of waterway shipment relative to other modes of delivery. For these reasons, the proposed investments are not expected to induce increased coal consumption.

- Implementation of the ORMSS recommendations would not be expected to significantly alter urban quality, historic/cultural resources, design of built environment or reuse and conservation of resources.

- No conflicts between the ORMSS recommendations and other government's land use policies, or controls were identified.

- Mitigation plans for site-specific impacts would be developed and justified during studies seeking approval or authorization for such improvements.

- Because the SIP/PEIS is a programmatic NEPA document, no additional federal permits or licenses are needed for implementation.

- Long-term sustainability of mussels and riparian/floodplain resources is an issue that remains to be resolved; however, meeting the needs of these resources will require efforts of many interests in addition to the Corps of Engineers and its cost-sharing partners under various ecosystem restoration authorities.

- Concerted efforts were made during the study process to adequately factor in uncertainties regarding reliability of lock chamber components, traffic projections under multiple scenarios, and reasonably foreseeable actions by the Corps of Engineers and others. Considering the types of concerns raised recently on other navigation improvement studies and the publicity surrounding those studies, it is anticipated that these uncertainties could become areas of controversy for the ORMSS.

c. Future System Investment Evaluations. In 2004, total *ORS* traffic reached 270 million tons and total ORS savings exceeded $2.0 Billion. The commodity value moving on the System annually exceeds $30 Billion. The uncertainties in any system investment plan that spans sixty years coupled with the potential of under investing in the right solutions and over investing in the wrong solutions, drive the need for a program of continual reevaluation of the system investment plans. In addition, because this study focused on the mainstem locks, a follow on investment evaluation capability must be designed to encompass dams, channels and any other feature which contributes to navigation efficiency. In addition, all of the navigable tributaries should be subject to the same rigor that the current study employed. A follow on capability should be established to build on the methodologies of ORMSS and expand the evaluations to include the entire navigation infrastructure (including locks, dams and channels) on the Mainstem and the navigable tributaries. This initiative would develop and maintain the databases and models capable of providing the scientific basis for decision makers as they address the level of funding essential to provide an efficient and sustainable navigation system. The model results can be used to evaluate future investment decisions with a more holistic approach to optimize system benefits, to manage system risks, and to use performance based criteria.

6. Study Conclusions.

- The Ohio River mainstem is an important natural resource for the nation and together with its six primary navigable tributary rivers provides efficient water transportation for a vast portion of the Nation.

- Each of the traffic scenarios studied are reasonable assumptions of future waterway traffic demands. All of the scenarios studied show increases in navigation traffic in the study period. These scenarios present significant variations in traffic demand at specific locks, though all scenarios indicate traffic growth at a system level.

- At the present time, 25 percent of locks on the Ohio River have exceeded their design life. Within 10 years, 50 percent of the locks will be beyond their original design. Operation and Maintenance funding at the level required for a reactive maintenance scenario has a benefit to cost ratio ranging from 22.7 to 24.6:1 (see Table 8-8 of this report). Proactive maintenance including both component replacements and major rehabilitation would provide national economic development benefits of hundreds of millions of dollars annually over and above the benefits achieved through reactive maintenance. The incremental benefit cost ratio for the WPC ranges from 7.8 to 12.7:1, depending upon the traffic scenario.

- No additional authorities are necessary at this time to address the needs related to the reliability of the locks. Follow-on studies are needed for recommended major rehabilitations and lock improvements.

- The need for early construction of new main lock chambers at the three upper Ohio River locks, namely Emsworth, Dashields, and Montgomery, is apparent across all traffic forecast scenarios.

- Minor repairs and small jobs associated with routine maintenance would cause only localized and limited effects on the ten VECs evaluated in the cumulative effects analysis. Routine maintenance, scheduled maintenance, and an N-Up/N-Down lockage policy would be expected to reduce tow queuing prior to passage through the locks, and to facilitate tow movement through the locks in a timelier manner and thus provide beneficial impacts (effects) on several VECs. Such beneficial effects would result from reductions in localized water turbidity levels; decreases in habitat disturbances for fish, mussels, and riparian resources; lowered accident potentials; and improved recreation opportunities.

- High priority ecosystem sustainability measures are needed for the Ohio River and associated resources on a large scale. These include habitat protection and restoration, control of exotic species, reintroduction of native species, improved connectivity of habitats, and reduction of sources of degradation. These measures are needed to help improve sustainability of many resources including mussels and riparian/floodplain habitats and the species they support.

- The conduct of this study was assessed in accordance with the seven Corps of Engineers Environmental Operating Principles and was found to be consistent with all of them.

- The Lock Modernization Alternative would result in lesser cumulative effects than the other plans. Reduction of cumulative effects would be a positive contribution to sustainability of water quality, fish, mussels, riparian resources, recreation, and health and safety.

- The Cumulative Effects Assessment indicated that future navigation investments would not adversely impact long-term resource sustainability. However, mussels and riparian/floodplain resources are not expected to become fully sustainable in the future due to continued degradation from previous actions combined with the future actions identified.

7. Study Recommendations.

ORMSS draft SIP recommendations follow. The annual costs for the SIPs over the period 2010 to 2030 are shown in Table 5.

- Increase Operation and Maintenance (O&M) investments to maximize economic efficiency. Complete all authorized navigation improvements; Olmsted, JT Myers, McAlpine, Greenup, Lower Monongahela, Kentucky Lock and Chickamauga.

- Provide optimal funding for the Upper Ohio River Study currently underway in order for this project to be included in a WRDA in the FY 2010 time frame.

- Initiate main chamber rehabilitation studies for Meldahl, Hannibal, and Myers and complete by 2009. Initiation of design and construction of these efforts should begin in 2010.

- Initiate main chamber rehabilitation study for Pike Island to complete in 2014.

- Pursue planning and implementation of measures to improve environmental sustainability in collaboration with other interests.

- Initiate preparation of the Program Implementation Plan for the Ohio River Ecosystem Restoration Program.

- Incorporate Reasonable and Prudent Measures developed during consultation under Section 7 of the Endangered Species Act into normal Operations and Maintenance.

- Complete work on the Markland gates as soon as possible. Funds provided in FY 2006 will initiate design and continued funding in FY 2007 and 2008 will construct the gates and place them in service.

- All detailed evaluation of site-specific impacts for follow on studies and other actions would be tiered from the SIP/PEIS.

- Initiate an Ohio River Basin Comprehensive Study which would provide the Corps with the opportunity to review basin-wide water resources in a holistic manner.

- Establish a stand alone program (Ohio River Navigation System Investment Program) to update the data and models used in preparing the System Investment Plan. Expand the program capability to include the Ohio River dams and include tributary (Allegheny, Monongahela, Kanawha, Green, Tennessee and Cumberland Rivers) locks and dam structures to support navigation investment decisions and manage future system risk. Use these tools in annual budget formulation.

- Use the Ohio River Navigation System Investment Program to reexamine the medium and long term needs identified in the SIP to optimize investments on these projects.

- Provide optimal funding for the Upper Ohio River Study currently underway in order for this project to be included in a WRDA in the FY 2010 time frame.

- Complete work on the Markland gates as soon as possible. Funds provided in FY 2006 will initiate design and continued funding in FY 2007 and 2008 will construct the gates and place them in service.

- All detailed evaluation of site-specific impacts for follow on studies and other actions would be tiered from the SIP/PEIS.

- The System Investment Plan was not developed considering a constrained federal budget or considering the total Ohio River System. Follow on actions need to be conducted to analyze investment strategies with a constrained federal budget and expanded to include all navigation locks, dams and channels on the Ohio River and its navigable tributaries.

Table 5
Annual Costs of Optimal SIP Actions,
By Scenario Over Time Period 2010 to 2030
($ Millions)

Year	Clear Skies	Modified Clear Skies	NAAQS	Utility Based	Utility Based High
2010	237.87	237.67	238.25	237.45	237.43
2011	124.76	134.59	135.39	127.90	134.41
2012	107.97	111.76	112.67	108.67	111.78
2013	92.95	95.83	95.75	100.90	95.94
2014	231.80	280.39	216.65	285.21	281.20
2015	292.74	295.82	320.75	289.95	294.27
2016	292.61	295.95	323.06	295.10	299.68
2017	152.21	100.12	205.62	101.66	95.86
2018	91.01	101.02	96.56	106.10	91.00
2019	72.95	84.09	73.13	85.60	78.40
2020	72.27	79.11	74.84	80.00	76.83
2021	78.02	73.38	79.94	73.32	73.40
2022	73.59	64.86	69.22	64.80	67.12
2023	67.55	66.20	66.85	66.13	68.46
2024	56.24	55.09	55.35	55.01	56.73
2025	69.22	66.38	62.18	64.39	62.23
2026	69.70	57.68	59.92	57.59	57.69
2027	78.33	68.10	68.76	68.26	61.86
2028	63.57	64.78	63.70	62.40	71.40
2029	71.51	66.54	64.39	66.27	79.29
2030	74.44	66.18	73.36	71.70	74.93